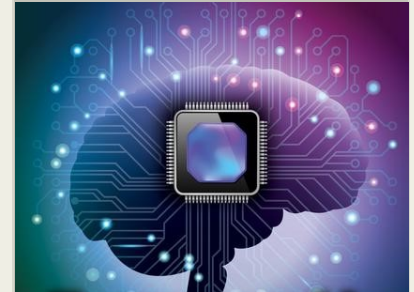## Project Introduction

In the latter half of the 20th century, microprocessors faithfully adhered to Moore's law, the well-known formulation of exponentially improving performance. As Gordon Moore originally predicted in 1965, the density of transistors, clock speed, and power efficiency in microprocessors doubled approximately every 18 months for most of the past 60 years. Yet this trend began to languish over the last decade. A law known as Dennard scaling, which states that microprocessors would proportionally increase in performance while keeping their power consumption constant, has broken down since about 2006; the result has been a trade-off between speed and power efficiency. Although transistor densities have so far continued to grow exponentially, even that scaling will stagnate once device sizes reach their fundamental quantum limits in the next ten years.

Due to this stagnation, processors, like those used for NASA's navigation, communication, and telemetry systems, lack the scaling necessary to push space exploration further. A more energy efficient architecture/technology is required in order to increase the information bits per unit energy, and push processors architectures pass the thermal limits currently preventing increased speeds. Photonic integrated circuit (PIC) platforms provide a solution to this emerging challenge. PICs are becoming a key part of communication systems in data centers, where microelectronic compatibility and high-yield, low-cost manufacturing are crucial. Because of their integration, PICs can allow photonic processing at a scale impossible with discrete, bulky optical-fiber counterparts, and scalable, CMOS-compatible silicon-photonic systems are on the cusp of becoming a commercial reality. More specifically, Neuromorphic Photonics allow for the benefits of PICs to be merged with the benefits associated with non Von-Neumann processor architectures allowing for increases in both speed and energy efficiency.

Anticipated Benefits

Neuromorphic photonics provide significant speed and efficiency increases with numerous potential applications. For NASA missions, neuromorphic photonics opens up a lot of potential in general purpose processors used for navigation, long-range communications, RF signal processors, and other systems used for spacecraft control. Neuromorphic photonic processors would have far reaching effects on most digital and analog electronic processes involved in NASA missions.

In the commercial and defense market, neuromorphic photonic processors have the potential to revolutionize computing and help push microprocessors beyond constraining thermal limits. This would allow for increased speed and energy efficiency in high performance computing in research and other demanding environments and RF signal processors for telecommunications. Moving past the Von-Neumann efficiency wall while increasing processing speeds has the potential to revolutionize modern computing.

Neuromorphic Processors for Next Generation Systems, Phase I
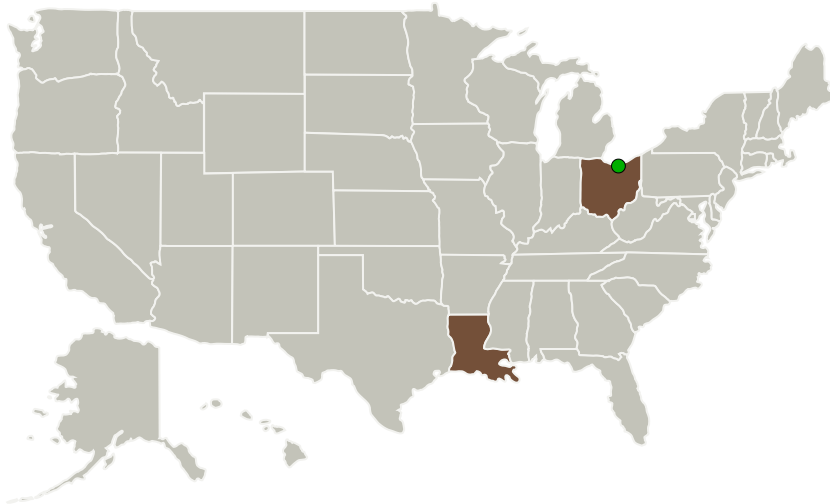
Table of Contents

Primary U.S. Work Locations and Key Partners

Organizations Performing Work	Role	Type	Location
Bascom Hunter Technologies, Inc.	Lead Organization	Industry	Baton Rouge, Louisiana
●Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Louisiana	Ohio

Project Transitions

▶ **July 2018:** Project Start

✓ **February 2019:** Closed out

Closeout Documentation:
- Final Summary Chart(*https://techport.nasa.gov/file/137874*)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Bascom Hunter Technologies, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:
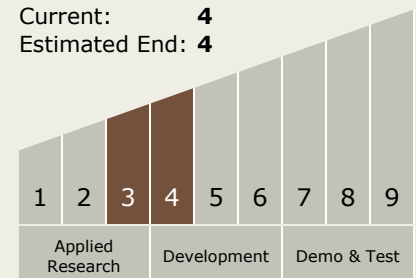
Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Joshua Lala

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**

1	2	3	4	5	6	7	8	9
Applied Research			Development			Demo & Test		

Images

Briefing Chart Image
Neuromorphic Processors for Next
Generation Systems, Phase I
*(https://techport.nasa.gov/imag
e/136192)*
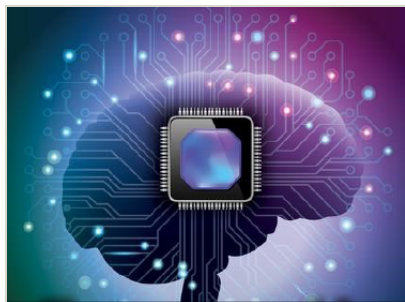
Final Summary Chart Image
Neuromorphic Processors for Next
Generation Systems, Phase I
*(https://techport.nasa.gov/imag
e/135030)*

Final Summary Chart Image
Neuromorphic Processors for Next
Generation Systems, Phase I
*(https://techport.nasa.gov/imag
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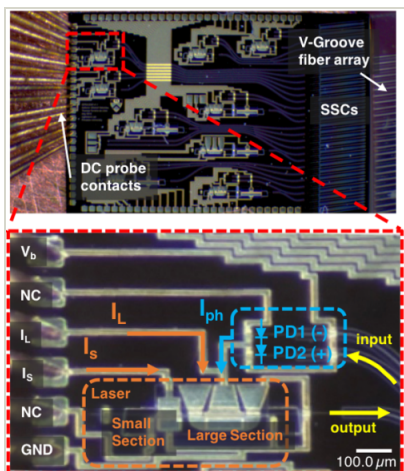
Technology Areas

Primary:

- TX05 Communications,
  Navigation, and Orbital
  Debris Tracking and
  Characterization Systems
  └ TX05.5 Revolutionary
     Communications
     Technologies
     └ TX05.5.2 Quantum
        Communications

Target Destinations

The Moon, Mars, Earth